

Locality.	Greenwich Time of Occurrence.			Time Occupied by Transit.	Approx. Distance from Callao. Naut. Miles.	Rate of Transit. Miles per Hour.
	D.	H.	M.			
Apia, N. Pacific ... ..	14	2	28	15.48	6590	417
Lyttleton, N.Z. ... ..	14	4	20	17.36	5720	327
Sydney ... ..	14	6	10	17.30	6907	394
Adelaide ... ..	14	11	40	25.00	7383	295
King George's Sound ...	14	12	28	25.30	7846	308

He pointed out that there appeared to be a retardation of the wave as the distance from the centre of disturbance increased; and that the late hour at which it was felt at Adelaide would be accounted for by the position of that place with respect to the southern coast line of Australia. It was also suggested that the apparent retardation might be the result of assuming the centre of disturbance too far east from the Australian coast: at Callao, for instance, whilst it might really have been in the Pacific a long way to the west of that place. If such were the case it would make the rates of the wave transit much more equable. The average rate of transit, omitting Adelaide, was 381 miles per hour; in the great earthquake at Simoda in Japan in 1854, the rate of transit, from observations made at San Francisco, was 370 miles per hour.\*

ART. XX.—*Notes on the Secondary Beds of Northern Australia.* By H. A. THOMPSON, Esq.

[Read by Mr. Rawlings, 9th November, 1868.]

Some time ago a considerable degree of interest was taken in the papers read by Professor M'Coy, bringing under the notice of the Royal Society the existence of secondary rocks on this continent, as indicated by the fossil bones of the ichthyosaurus and pleisiosaurus, and cretaceous shells discovered on the Flinders River, near the Gulf of Carpentaria.

Having lately crossed the country where these organic remains were found, it may be of some interest to communicate the few observations that were made in the course of a rapid journey from Cleveland Bay on the east coast to the

\* Mallet's Report on Earthquakes. Brit. Assoc. Report, 1858, page 126.

parallel of the  $140^{\circ}$  of the east longitude, and between south latitudes  $19^{\circ}$  and  $21^{\circ}$ .

The object of the journey was to examine the outcrop of copper ore, discovered on the head-waters of the Cloncurry river in latitude  $20^{\circ} 42'$  south. The appended sketch-map shows the route followed, and the section is intended to represent the outline and character of the formations on the line travelled over.

This section of country may be divided into three parts :—first, the coast lands, and the belt of high table land constituting the coast range ; second, the wide valley west of the coast range known as the Flinders Plains ; and, third, the hilly country bounding the Flinders Plains on the west, known as the M'Kinlay Ranges.

In this portion of eastern Australia, the coast range approaches close to the sea, and the high rugged islands off the coast, together with the spurs and outlying hills between the eastern escarpment of the range and the present coast line, shows that the sea has made extensive inroads into the eastern side of the table-land.

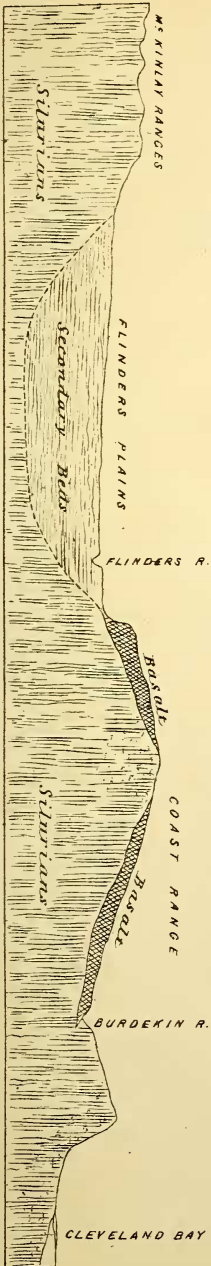
Near Cleveland Bay, the main range is between twenty and thirty miles from the sea ; the intervening country consisting of gently rising plains ; broken by spurs running at right angles to the range, and detached hills rising abruptly from the low ground.

On the eastern face, the main range presents a bold and rugged front, between 2,000 and 3,000 feet in height, so precipitous that the existence of the small settlements on the coast generally depends on the discovery of a practicable road up this face, to enable a trade to be carried on with the interior.

The amount of denudation effected by the streams running through these coast plains is not so great as to indicate the lapse of any long period of time since their elevation above the sea, and a small depression of the land would convert the hills into a bold, rocky coast with deep bays and inlets.

From the summit of the range the ground falls towards the Burdekin River, which is crossed at a distance of seventy-five miles from the coast. Beyond the Burdekin the country rises gradually for about one hundred miles to the ridge forming the water-shed to the interior.

The total width of this table-land running parallel with the east coast is over two hundred miles. It is traversed from north-west to south-east by the great longitudinal



SECTION



valley of the Burdekin, having a course of some four hundred miles, and then joining a similar valley coming from the south, when the united waters break out of the table-land and escape to the east coast. The Burdekin is fed by tributaries coming from each side of the valley; but the western side is the principal drainage area.

From the coast to the top of the range the road passes over granite rocks, and beyond this the same rock alternates with bands of silurians up to the east bank of the Burdekin. The western bank consists of basaltic rock, and the present river-channels is of modern date, worn out on the line of junction between the basalt and the silurians, after the deeper part of the old valley had been covered up by the volcanic rocks.

Leaving the Burdekin, the road passes over basaltic rock for about one hundred miles, when the auriferous formation near the head of the Cape River crops out. This consists of bands of metamorphosed silurians, from whence specimens might be selected in all stages of the change from a schistose to a granitic character. Beyond this granite again prevails, and then the older rocks are covered up with basalt up to the edge of the Flinders Plains. The road from the range leads down a gorge worn in the volcanic rock, which at its junction with the Flinders River must be over three hundred feet in depth.

This escarpment forms the western flank of the coast range, and from it extends the country known as the Flinders Plains, to the coast at the Gulf of Carpentaria on the north, and to the M'Kinlay Ranges on the west, the latter being a distance of some two hundred miles.

This wide valley is nearly level country, with slight depressions in the neighbourhood of the larger water courses. Where crossed, its main drainage-channel is the Flinders River running to the Gulf, and receiving many tributaries from the west, having their origin in the M'Kinlay Ranges. Some fifteen of these small creeks were struck in travelling across the plains from the Flinders to the Cloncurry, and the latter river joins the Flinders about one hundred miles north of the line travelled over. These water-courses frequently spread out into numerous branches in the level plains, and in some places it is difficult to make out which is the main channel. At the Flinders and Cloncurry rivers, there is a narrow belt of timber on each side of the stream, then green banks from ten to thirty feet deep, and between these a wide



bed of dry white sand and gravel, with water-holes at uncertain intervals, more frequently found in some of the ana-branches than in the main channels; but water may generally be procured by sinking wells in the sandy beds of the larger rivers.

The tributary creeks have much the same character on a smaller scale; but in these the timber is confined to a single line round the water-holes, and the plains are for the most part treeless.

After heavy storms a torrent may roll down these water-courses for a few days, but when the rain ceases they soon resume their usual arid appearance.

The soil is sandy and loose, rising up in a spongy mass in wet weather, when many parts of the plains become nearly impassable, and in dry weather opening in innumerable fissures. Miles of country may be ridden over without seeing a square yard of unbroken surface. This character will of course be greatly modified as the surface is trodden firm by stock.

In all the sections observed, the underlying formation was a fine-grained sandstone in horizontal beds, apparently undisturbed. Flattened nodules of limestone, often enclosing fossil shells, were scattered about the surface in many places; but no limestone beds were seen.

Cretaceous shells were picked up on the Flinders River, near the centre of the plains, and near the junction of the horizontal sandstone beds with the rocks of the M'Kinlay ranges.

The place where the bones of the ichthyosaurus and pleisiosaurus were found is on the point of a low rise bounding the flats of the Flinders River, and about six miles from its present channel. Here we have the same sandstone formation in horizontal beds; but the saurian bones, and most of the shells, were found on the surface of the soil. The first discoverer of one of the saurians described it to me as presenting the exact appearance of an animal, whose body had decayed on the surface, leaving the skeleton on the grass. The singular position in which these shells and bones are found is evidently owing to the friable nature of the sandstone in which they have been enclosed; the slow disintegration and gradual removal of this rock having at length left the harder fossils on the surface.

In some places where the rock was exposed the apparently hard stones crumbled to pieces in the hand, indicating the

source from whence the sandy alluvial deposit of the plains had been derived.

Several of the shells brought down were broken from the sandstone rocks, where they had formed layers of organic remains on the bedding planes.

Approaching the western edge of the plains, the M'Kinlay Ranges are first seen at a distance of thirty to forty miles, but the Silurian formation, of which they consist, extends for some miles into the plains. The only portion examined was a bight or hollow in the range, where it trends back to the westward (the general direction being north and south), and whence the drainage of a considerable area makes its escape to the plains through the Cloncurry River and its tributaries. This portion of the country is slightly undulating, studded with detached hills, and crossed by low ridges, with the rock here and there cropping above the surface of the ground. Occasionally detached masses of rock rise abruptly on the line of these ridges from twelve to fifty feet in height—or peaks and oblong hills follow the same lines. The country shows no sign of active denudation, and its present form is due to the slow disintegration of the rock, and the gradual removal of the finer particles. All the gravel observed was angular, both on the surface and in a shaft sunk in the bed of a small creek when looking for water. Rolled drift will probably be found in the bed of the Cloncurry River and some of the larger streams.

The detached masses of rock and small hills in most instances consist of rock impregnated with iron, or changed into quartzite. In one place a low rise was crested for several hundred feet by a quartz vein from five to six feet wide and from twelve to twenty feet high, cropping up white and bare above the grass, with vertical sides and sharp angles, giving little indications of wear. In these cases the hardened rock or quartz had resisted the action of the weather, while the softer rock decayed, and was gradually washed away.

To a certain extent the same may be said of the low ridges—these consisting of ironstone, quartzite, and in some places a semi-granitic rock. The constituents of the latter form of rock seemed to be collecting into separate bodies, so as to resemble a coarse granite; and in the weathering of the rock the softer portions had been worn away, leaving the harder parts projecting on the surface, and rounded by exposure, so as to resemble a conglomerate, for which it was

at first mistaken. All these forms could be seen on the same ridge, but the trenches proved that this change only affected the surface, and did not penetrate to any depth.

The prevailing rock was a sandy schist, but bands of slate with vertical cleavage, and masses of porphyritic and granitic rocks, were mixed with it. Patches of dolomite, both in the grey compact and white crystalline form, were also met with at intervals. No fossils were found in these rocks, so that their exact position cannot be determined; but I have no doubt as to their being Silurians, which have undergone metamorphic action, similar to that affecting the same formation in the coast range.

Traces of copper ore are found in great abundance, and one very rich and extensive deposit of red oxide of copper has been partially opened; while, considering the small area yet explored, it is probable many productive mines will be discovered in these ranges. Even now there will soon be a large mining establishment on the river, down whose banks Messrs. Burke and Wills toiled in their journey to the Gulf.

One singular fact noted in these ranges was the distance to which the heat had penetrated into the ground. In a shaft sunk to a depth of forty-four feet there was no diminution in this heat. When leaving the hot midday sun of the tropics, going down this shaft produced a feeling similar to that sustained on entering a Turkish bath. The rock at the bottom felt warm to the hand, and in two or three minutes after reaching it the perspiration burst from every pore.

It will be interesting to mark the depth at which a mean temperature will be found in this mine.

However incomplete these observations—made during a hurried journey, and for the most part from the saddle—necessarily must be, they yet establish the fact that between the coast range and the M'Kinlay Ranges there has existed a deep depression or valley, extending from the Gulf of Carpentaria to the twenty-first degree of south latitude, and that this depression was filled by the sea during the secondary era for a period long enough to allow of the deposition of the sandstone beds, from whence the fossils described by Professor M'Coy have been obtained; and further, that these secondary beds show no indication of disturbance, or of active denudation.

Limited as this knowledge is, it may form a starting-point for other observers, whose accumulated discoveries will un-



ravel the history of the continent during this epoch, and much valuable information may perhaps be obtained by pointing out the questions requiring solution.

1. Does the depression in which these secondary beds have been deposited extend across the continent as an arm of the sea, or is it a large inlet, and if it is the latter, where does it terminate?

About 100 miles south of the route followed we have the watershed between the streams running to the north, and those running south into Cooper's Creek. This is a likely point for the supposed inlet to terminate, and it should be examined to see if the silurian rocks stretch across from the coast range to the M'Kinlay Ranges. If the depression has been an arm of the sea running from the north to the south coast, and dividing the continent into two or more islands, by what line does it reach the southern coast? This ought to be readily traced, for the horizontal sandstones may be easily distinguished from the silurian sandstones with vertical cleavage even by an inexperienced eye. Can these beds underlay the alluvium of the Lachlan and Lower Murray plains, or do they find a passage to the westward by the valley of Cooper's Creek, dividing the M'Kinlay Ranges from the Barrier Ranges west of the Darling?

2. Does the M'Kinlay Ranges form the western boundary of the inlet or strait, or has this range formed a promontory projecting into or been an island in the secondary sea?

This question as to the extension of the secondary rocks to the westward is a very interesting one. All I have been able to make out is, that the silurians are found on the Gregory, and the upper waters of that river are running through basaltic plains. The secondary rocks must be found to the westward of this river if they extend in this direction.

3. Has the secondary formation originally extended over a much larger area than it now occupies, and since been denuded?

If such has been the case, some patches of these secondary rocks will most likely be discovered mixed with the adjoining silurians, or at least some fossils may be found, indicating these rocks have covered the silurians.

Judging, however, from the undisturbed character of these rocks, and the absence of rolled drift, or any indication of strong denuding action, I believe this question will eventually be answered in the negative.